

# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-073778

(43)Date of publication of application : 17.03.1998

(51)Int.Cl.

G02B 26/10

G02B 26/10

B41J 2/44

G02B 3/06

G02B 13/00

(21)Application number : 09-171044

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(22)Date of filing : 11.06.1997

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(30)Priority

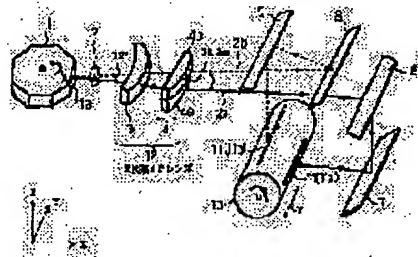
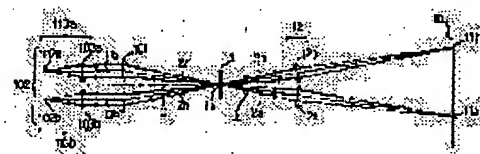
Priority number : 08174332 Priority date : 13.06.1996 Priority country : JP

## (54) SCANNING OPTICAL DEVICE AND LASER BEAM PRINTER DEVICE

(57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a scanning optical device and a laser printer device capable of spatially separating the plural beams by oblique incidence in a compact scanning optical device of an enlarging system compensating the curvature of a scanning line and preventing the deterioration of image forming performance.

**SOLUTION:** This scanning optical system makes plural light beams radiated from a light source means 102 having plural light emitting parts incident on the deflection surface of a deflecting means 1 through an optical means, plural light beams deflected by the deflecting means is introduced to a surface to be scanned 10 through an image forming means 12 and the surface to be scanned 10 is scanned by the plural light beams. The image forming means 12 has plural rotationally asymmetric lenses 4a, 4b, the optical axes of the plural rotationally asymmetric lenses 4a, 4b are parallel with the light beams incident on the relevant lenses and the shape of generatrix connecting the vertexes of the relevant plural rotationally asymmetric lenses 4a, 4b is composed of a curve bent in each sub-scanning direction.



## LEGAL STATUS

[Date of request for examination]

08.06.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than  
the examiner's decision of rejection or  
application converted registration]

[Date of final disposal for application]

[Patent number]

3450653

[Date of registration]

11.07.2003

[Number of appeal against examiner's decision  
of rejection]

[Date of requesting appeal against examiner's  
decision of rejection]

[Date of extinction of right]

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**CLAIMS**

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**[Claim(s)]**

[Claim 1] Incidence of two or more light beams emitted from a light source means to have two or more light-emitting parts is carried out to the deviation side of a deflection means through an optical means. In the scan optical equipment which carries out the light guide of two or more light beams deflected by this deflection means on a scan layer-ed through an image formation means, and scans this scan-layer-ed top by two or more light beams The bus-bar configuration which this image formation means has two or more rotation unsymmetrical lenses, and the optical axis of two or more of these rotation unsymmetrical lenses is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of two or more of these rotation unsymmetrical lenses is scan optical equipment characterized by consisting of the curve which curved in the direction of vertical scanning respectively.

[Claim 2] While carrying out incidence of said two or more light beams which carry out incidence to the deviation side of said deflection means at an include angle symmetrical with abbreviation to the optical axis of said optical means into a vertical-scanning cross section, the bus-bar configuration of two or more of said rotation unsymmetrical lenses is scan optical equipment of claim 1 characterized by being mirror symmetry to a symmetry axis.

[Claim 3] The bus-bar of one [ at least ] lens side of two or more of said rotation unsymmetrical lenses is scan optical equipment of claim 1 characterized by having shifted in the direction of vertical scanning to the optical axis of this lens.

[Claim 4] Said optical means is scan optical equipment of claim 1 characterized by carrying out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means.

[Claim 5] The deviation side and said scan layer-ed of said deflection means are scan optical equipment of claim 1 characterized by having an optical conjugation relation with said image formation means into a vertical-scanning cross section.

[Claim 6] Said image formation means is scan optical equipment of claim 1 characterized by having a cylindrical lens.

[Claim 7] Incidence of two or more light beams emitted from a light source means to have two or more light-emitting parts is carried out to the deviation side of a deflection means through an optical means. In the scan optical equipment which carries out the light guide of two or more light beams deflected by this deflection means on a scan layer-ed through an image formation means, and scans this scan-layer-ed top by two or more light beams It is scan optical equipment which this image formation means has two or more toric lenses, and is characterized by the optical axis of two or more of these toric lenses leaning in a vertical-scanning cross section to an incident beam respectively.

[Claim 8] Said optical means is scan optical equipment of claim 7 characterized by carrying out incidence of two or more light beams emitted from said light source means in the condition [ \*\*\*\* / un- ] to the deviation side of said deflection means.

[Claim 9] Said two or more light beams are scan optical equipment of claim 8 characterized by carrying out incidence at an include angle symmetrical with abbreviation to the optical axis of

said optical means the deviation side of said deflection means in a vertical-scanning cross section.

[Claim 10] Said optical means is scan optical equipment of claim 7 characterized by carrying out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means.

[Claim 11] The deviation side and said scan layer-ed of said deflection means are scan optical equipment of claim 7 characterized by having an optical conjugation relation with said image formation means into a vertical-scanning cross section.

[Claim 12] Said image formation means is scan optical equipment of claim 7 characterized by having a cylindrical lens.

[Claim 13] In the scan optical equipment which is made to carry out incidence of the light beam emitted from the light source means to the deviation side of a deflection means through an optical means, carries out the light guide of the light beam deflected by this deflection means on a scan layer-ed through an image formation means, and carries out light scanning of this scan-layer-ed top The bus-bar configuration which this image formation means has a rotation unsymmetrical lens, and the optical axis of this rotation unsymmetrical lens is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of this rotation unsymmetrical lens is scan optical equipment characterized by consisting of the curve which curved in the direction of vertical scanning.

[Claim 14] The bus-bar of one [ at least ] lens side of said rotation unsymmetrical lens is scan optical equipment of claim 13 characterized by having shifted in the direction of vertical scanning to the optical axis of this lens.

[Claim 15] Said optical means is scan optical equipment of claim 13 characterized by carrying out incidence of the light beam emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means.

[Claim 16] The deviation side and said scan layer-ed of said deflection means are scan optical equipment of claim 13 characterized by having an optical conjugation relation with said image formation means into a vertical-scanning cross section.

[Claim 17] Said image formation means is scan optical equipment of claim 13 characterized by having a cylindrical lens.

[Claim 18] A light source means to have two or more light-emitting parts, and the deflection means which deflects two or more light beams emitted from this light source means, In the scan optical equipment which has the optical means which carries out the light guide of two or more light beams emitted from this light source means to this deflection means, and the image formation means which carries out the light guide of two or more light beams deflected by this deflection means on a scan layer-ed The bus-bar configuration which this image formation means has two or more rotation unsymmetrical lenses, and the optical axis of two or more of these rotation unsymmetrical lenses is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of two or more of these rotation unsymmetrical lenses is scan optical equipment characterized by consisting of the bus-bar which curved in the direction of vertical scanning.

[Claim 19] Said optical means is scan optical equipment of claim 18 characterized by carrying out incidence of two or more light beams emitted from said light source means in the condition [ \*\*\*\* / un- ] to the deviation side of said deflection means.

[Claim 20] Said two or more light beams are scan optical equipment of claim 19 characterized by carrying out incidence at an include angle symmetrical with abbreviation to the optical axis of said optical means to the deviation side of said deflection means in a vertical-scanning cross section.

[Claim 21] Said optical means is scan optical equipment of claim 18 characterized by carrying out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means.

[Claim 22] The deviation side and said scan layer-ed of said deflection means are scan optical equipment of claim 18 characterized by having an optical conjugation relation with said image formation means into a vertical-scanning cross section.

[Claim 23] The bus-bar configuration of two or more of said rotation unsymmetrical lenses is scan optical equipment of claim 18 characterized by being mirror symmetry to a symmetry axis.

[Claim 24] The bus-bar of one [ at least ] lens side of two or more of said rotation unsymmetrical lenses is scan optical equipment of claim 18 characterized by having shifted in the direction of vertical scanning to the optical axis of this lens.

[Claim 25] Said image formation means is scan optical equipment of claim 18 characterized by having a cylindrical lens.

[Claim 26] A light source means to have two or more light-emitting parts, and the deflection means which deflects two or more light beams emitted from this light source means. In the laser beam printer equipment which has the optical means which carries out the light guide of two or more light beams emitted from this light source means to this deflection means, a record medium, and the image formation means which carries out the light guide of two or more light beams deflected by this deflection means on a record-medium side This image formation means has two or more rotation unsymmetrical lenses, and the optical axis of two or more of these rotation unsymmetrical lenses is the light beam and abbreviation parallel which carry out incidence to this lens. And the bus-bar configuration which connects the meridian top-most vertices of two or more of these rotation unsymmetrical lenses is laser beam printer equipment characterized by consisting of the bus-bar which curved in the direction of vertical scanning.

[Claim 27] Said optical means is laser beam printer equipment of claim 26 characterized by carrying out incidence of two or more light beams emitted from said light source means in the condition [ \*\*\*\* / un- ] to the deviation side of said deflection means.

[Claim 28] Said two or more light beams are laser beam printer equipment of claim 27 characterized by carrying out incidence at an include angle symmetrical with abbreviation to the optical axis of said optical means to the deviation side of said deflection means in a vertical-scanning cross section.

[Claim 29] Said optical means is laser beam printer equipment of claim 26 characterized by carrying out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means.

[Claim 30] The deviation side and said record-medium side of said deflection means are laser beam printer equipment of claim 26 characterized by having an optical conjugation relation with said image formation means into a vertical-scanning cross section.

[Claim 31] The bus-bar configuration of two or more of said rotation unsymmetrical lenses is the laser beam printer of claim 26 characterized by being mirror symmetry to an axis of symmetry.

[Claim 32] The bus-bar of one [ at least ] lens side of two or more of said rotation unsymmetrical lenses is laser beam printer equipment of claim 26 characterized by having shifted in the direction of vertical scanning to the optical axis of this lens.

[Claim 33] Said image formation means is laser beam printer equipment of claim 26 characterized by having a cylindrical lens.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention carries out light scanning of the record-medium (photoconductor drum) side top using two or more light beams by which were made to carry out incidence of the light beam emitted from a light source means to have two or more light-emitting parts especially at an angle of predetermined [ in a vertical-scanning cross section ] to the deviation side of a deflection means about scan optical equipment and laser beam printer equipment, and deviation reflection was carried out by this deflection means, and is made to record image information.

[0002]

[Description of the Prior Art] The multi-beam scan optical equipment which is made to carry out incidence of two or more light beams to common scan optical system, and realizes multicolor from before is proposed [ that it is various and ]. Although it is necessary to separate these two or more light beams after deviation reflection is carried out by the optical deflector (for example, polygon mirror) in this kind of multi-beam scan optical equipment for irradiating two or more light beams independently on a predetermined scan layer-ed, respectively, to the light source of the same wavelength, space separation is needed. For example, if incidence of the light beam is carried out from across in a vertical-scanning cross section to the deviation side (reflector) of an optical deflector, the target space separation will be attained.

[0003] However, in the scan optical equipment of an expansion system with which an optical configuration becomes compact, since the optical path length for space separation is short, the oblique incidence angle over a deviation side becomes large, and for this reason, two big troubles shown below occur.

[0004] The 1st trouble is the scanning-line deflection on a scan layer-ed, and the 2nd trouble is degradation of the image formation engine performance. These troubles are explained using the optical system of drawing 15.

[0005] Drawing 15 (A) and (B) are the important section sectional views of the optical system made to put slanting ON respectively at the scan optical equipment of the conventional expansion system. This drawing (A) is a horizontal-scanning sectional view, this drawing (B) is a vertical-scanning sectional view perpendicular to the space of this drawing (A), and this drawing (A) and (B) show the situation after two light beams which countered and carried out oblique incidence to the deviation side of an optical deflector carry out deviation reflection in respect of this deviation.

[0006] In this drawing (A) and (B), 21 is an optical deflector, for example, consists of the polygon mirror. Two oblique incidence beams of light with which deviation reflection of 22a and the 22b was carried out by the polygon mirror, and 32 are image formation means, and consist of ftheta lens of the two-sheet system of the cylindrical lens 23 and the two-step toric lens 24 which have predetermined refractive power only in a horizontal-scanning cross section. The cylindrical lens 23 earned the lens back of the ftheta lens 32, brought the whole lens close to the polygon mirror 21 side, and has contributed to the miniaturization of optical system. The two-step toric lens 24 has separated in the direction of vertical scanning at the toric lenses 24a and 24b of two

upper and lower sides, as shown in this drawing (B), and each toric lenses 24a and 24b are independently arranged on two above-mentioned cores of the oblique incidence beams of light 22a and 22b.

[0007] Although not illustrated about the incidence system which makes two light beams put to the polygon mirror 21 slanting ON in this drawing, after two or more light beams emitted from two or more light sources corresponding to two oblique incidence beams of light 22a and 22b are changed into the parallel flux of light by the collimator lens, a line image is formed near the deviation side 21a of the polygon mirror 21 only in a vertical-scanning cross section by the cylindrical lens which has predetermined refractive power. This is a means used in order to amend the failure by the field in the vertical-scanning cross section of the deviation side of a polygon mirror, it is making conjugation relation optically the deviation side and the scan layer-ed (photoconductor drum side) of a polygon mirror into the vertical-scanning cross section, namely, falls, and constitutes amendment optical system.

[0008] And two or more light beams (oblique incidence beam of light) 22a and 22b by which deviation reflection was carried out are led to the predetermined location on a photoconductor drum side through the non-illustrated optical-path bending mirror which corresponds respectively with the theta lens 32 by the polygon mirror 21. rotation of the photoconductor drum to which it was drawn by shaft orientations (main scanning direction where the deviation scan of the light beam is carried out), and the scanning line synchronized with rotation of this polygon mirror 21 by rotation of this polygon mirror 21 — this scanning line is formed in the direction of vertical scanning perpendicular to a main scanning direction at equal intervals. Thus, by irradiating the two scanning lines independently on one photoconductor drum side at coincidence, the development of two colors is attained by one rotation of this photoconductor drum, and improvement in the speed of color printing is realized.

[0009]

[Problem(s) to be Solved by the Invention] However, if a light beam was made to put slanting ON in a vertical-scanning cross section to deviation side 21a of the polygon mirror 21, since the trouble shown below would occur, oblique incidence was not used for expansion optical system in the former.

[0010] Hereafter, the trouble of this oblique incidence is explained to the bottom on a drawing paying attention to light beam (oblique incidence beam of light) 22a which carried out deviation reflection to the axis of symmetry x of the toric lenses 24a and 24b of drawing 15 (B).

[0011] The 1st trouble is produced when the light beam which carried out oblique incidence to the polygon mirror 21 to deviation side 21a in the vertical-scanning cross section (inside of a cross section perpendicular to a X-Y flat surface) as shown in drawing 16 (A) draws a conical surface by the deviation scan of this polygon mirror 21. The scanning line which curved to toric lens 24a arranged on the core of oblique incidence beam-of-light 22a carries out incidence, and a scanning-line curve appears as it is also in the photoconductor drum side as a scan layer-ed. This is the trouble of the scanning-line curve by oblique incidence. In expansion optical system, the oblique incidence angle theta needs to enlarge with about 3-6 degrees, and the amount of scanning-line curves on the photoconductor drum side by this is as large as 0.5mm to about several mm.

[0012] Although the approach of arranging an parallel plate (amendment glass) is, for example on an optical axis as this solution, in amendment by this parallel plate, glass becomes thick too much, and the whole equipment is enlarged, and there is a trouble of leading to high cost-ization.

[0013] The 2nd trouble is degradation of the image formation engine performance. The principle is shown in drawing 1616 (B), (C), and (D). This drawing (B) is an explanatory view having shown the light beam which carries out incidence to deviation side 21a of the polygon mirror 21 from the main scanning direction. In this drawing (B), P is U and a chief ray and L are the beams of light of the both sides of a chief ray P. This drawing (C) is an explanatory view when seeing this drawing (B) in a vertical-scanning cross section. As shown in this drawing (C), beams of light L, P, and U will be reflected as a beam of light with which the height of the direction of vertical scanning differs in this sequence. Since a light beam serves as the focal line which the incidence

side fell and carries out image formation in the direction of vertical scanning by the cylindrical lens for amendment (un-illustrating), beams of light L, P, and U serve as a rotated line image which had an angle of rotation  $\phi$  to the horizontal-scanning side (X-Y flat surface) on the deviation side of the polygon mirror 21 as shown in this drawing (D). This angle of rotation  $\phi$  changes in proportion to the angle of rotation of the polygon mirror 21.

[0014] The explanatory view and drawing 1717 (B) having shown the inclination of the beam of light [ drawing 17 / (A) ] in the vertical-scanning cross section on the deviation side of a polygon mirror are an explanatory view having shown the situation of the chief ray (P) locus after the deviation scan was carried out by the polygon mirror, the beam of light U of the circumference of a chief ray (P), and a beam of light L. A MERI cross-section beam of light is a beam of light within the X-Y flat surface defined by the incident light study system which carries out incidence of the light beam to a polygon mirror.

[0015] As shown in this drawing (A) and (B), the field angle in a horizontal-scanning cross section takes for becoming large (the absolute value of Y coordinate becoming large), and the angle of rotation  $\phi$  of beams of light L, P, and U becomes large. Since the direction of a bus-bar of toric lens 24a is parallel to a Y-axis at this time, the beams of light L and U of the circumference of a chief ray P receive unsymmetrical refractive power from a bus-bar. Consequently, beams of light L and U are rotated focusing on a chief ray P in a Y-Z side, refractive power is received also from the meridian direction of toric lens 24a, and the image formation engine performance deteriorates.

[0016] Since the angle of rotation  $\phi$  of a light beam becomes [ a horizontal-scanning field angle ] large, drawing 18 is the explanatory view having shown signs that the image formation engine performance deteriorated. The configuration of a spot becomes stellate and is confused, so that a horizontal-scanning field angle becomes large, as shown in this drawing.

[0017] This invention prevents degradation of the image-formation engine performance while amending a scanning-line curve good, and it aims at offer of the scan optical equipment which can enable space separation of two or more beams by oblique incidence in the scan optical equipment of a compact expansion system by constituting appropriately a lens configuration or a lens location of a toric lens etc. which is the rotation unsymmetrical lens which constitutes an image-formation means (ftheta lens).

[0018]

[Means for Solving the Problem] Scan optical equipment of this invention (1-1), incidence of two or more light beams emitted from a light source means to have two or more light-emitting parts is carried out to the deviation side of a deflection means through an optical means. In the scan optical equipment which carries out the light guide of two or more light beams deflected by this deflection means on a scan layer-ed through an image formation means, and scans this scan-layer-ed top by two or more light beams It is characterized by the bus-bar configuration which this image formation means has two or more rotation unsymmetrical lenses, and the optical axis of two or more of these rotation unsymmetrical lenses is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of two or more of these rotation unsymmetrical lenses consisting of the curve which curved in the direction of vertical scanning respectively.

[0019] Especially (1-1-1) While carrying out incidence of said two or more light beams which carry out incidence to the deviation side of said deflection means at an include angle symmetrical with abbreviation to the optical axis of said optical means into a vertical-scanning cross section The bus-bar configuration of two or more of said rotation unsymmetrical lenses is mirror symmetry to a symmetry axis, (1-1-2) The bus-bar of one [ at least ] lens side of two or more of said rotation unsymmetrical lenses is shifted in the direction of vertical scanning to the optical axis of this lens, (1-1-3) Said optical means carries out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means, (1-1-4) The deviation side and said scan layer-ed of said deflection means are having an optical conjugation relation with said image formation means in a vertical-scanning cross section (1-1-5), Said image formation means is characterized by having a cylindrical lens etc.

[0020] (1-2) Carry out incidence of two or more light beams emitted from a light source means to have two or more light-emitting parts to the deviation side of a deflection means through an optical means. In the scan optical equipment which carries out the light guide of two or more light beams deflected by this deflection means on a scan layer-ed through an image formation means, and scans this scan-layer-ed top by two or more light beams This image formation means has two or more toric lenses, and it is characterized by the optical axis of two or more of these toric lenses leaning in a vertical-scanning cross section to an incident beam respectively.

[0021] Especially (1-2-1) Said optical means carries out incidence of two or more light beams emitted from said light source means in the condition [ \*\*\*\* / un-] to the deviation side of said deflection means, (1-2-2) Incidence of said two or more light beams is carried out at an include angle symmetrical with abbreviation to the optical axis of said optical means to the deviation side of said deflection means in a vertical-scanning cross section, (1-2-3) Said optical means carries out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means, (1-2-4) The deviation side and said scan layer-ed of said deflection means are having an optical conjugation relation with said image formation means in a vertical-scanning cross section (1-2-5), Said image formation means is characterized by having a cylindrical lens etc.

[0022] (1-3) Carry out incidence of the light beam emitted from the light source means to the deviation side of a deflection means through an optical means. In the scan optical equipment which carries out the light guide of the light beam deflected by this deflection means on a scan layer-ed through an image formation means, and carries out light scanning of this scan-layer-ed top It is characterized by the bus-bar configuration which this image formation means has a rotation unsymmetrical lens, and the optical axis of this rotation unsymmetrical lens is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of this rotation unsymmetrical lens consisting of the curve which curved in the direction of vertical scanning.

[0023] Especially (1-3-1) The bus-bar of one [ at least ] lens side of said rotation unsymmetrical lens is shifted in the direction of vertical scanning to the optical axis of this lens, (1-3-2) Said optical means carries out incidence of the light beam emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means, (1-3-3) The deviation side and said scan layer-ed of said deflection means are having an optical conjugation relation with said image formation means in a vertical-scanning cross section (1-3-4), Said image formation means is characterized by having a cylindrical lens etc.

[0024] (1-4) A light source means to have two or more light-emitting parts, and the deflection means which deflects two or more light beams emitted from this light source means, In the scan optical equipment which has the optical means which carries out the light guide of two or more light beams emitted from this light source means to this deflection means, and the image formation means which carries out the light guide of two or more light beams deflected by this deflection means on a scan layer-ed The bus-bar configuration which this image formation means has two or more rotation unsymmetrical lenses, and the optical axis of two or more of these rotation unsymmetrical lenses is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of two or more of these rotation unsymmetrical lenses is scan optical equipment characterized by consisting of the bus-bar which curved in the direction of vertical scanning.

[0025] Especially (1-4-1) Said optical means carries out incidence of two or more light beams emitted from said light source means in the condition [ \*\*\*\* / un-] to the deviation side of said deflection means, (1-4-2) Incidence of said two or more light beams is carried out at an include angle symmetrical with abbreviation to the optical axis of said optical means to the deviation side of said deflection means in a vertical-scanning cross section, (1-4-3) Said optical means carries out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means, (1-4-4) The deviation side and said scan layer-ed of said deflection means have an optical conjugation relation with said image formation means in a vertical-scanning cross section, (1-4-5) The bus-bar configuration of two or more of said rotation unsymmetrical lenses is mirror symmetry to a

symmetry axis, (1-4-6) The bus-bar of one [ at least ] lens side of two or more of said rotation unsymmetrical lenses is having shifted in the direction of vertical scanning to the optical axis of this lens (1-4-7), Said image formation means is characterized by having a cylindrical lens etc. [0026] Laser beam printer equipment of this invention (2-1) A light source means to have two or more light-emitting parts, The deflection means which deflects two or more light beams emitted from this light source means, and the optical means which carries out the light guide of two or more light beams emitted from this light source means to this deflection means, In the laser beam printer equipment which has a record medium and the image formation means which carries out the light guide of two or more light beams deflected by this deflection means on a record-medium side It is characterized by the bus-bar configuration which this image formation means has two or more rotation unsymmetrical lenses, and the optical axis of two or more of these rotation unsymmetrical lenses is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of two or more of these rotation unsymmetrical lenses consisting of the bus-bar which curved in the direction of vertical scanning.

[0027] Especially (2-1-1) Said optical means carries out incidence of two or more light beams emitted from said light source means in the condition [ \*\*\*\* / un- ] to the deviation side of said deflection means, (2-1-2) Incidence of said two or more light beams is carried out at an include angle symmetrical with abbreviation to the optical axis of said optical means to the deviation side of said deflection means in a vertical-scanning cross section, (2-1-3) Said optical means carries out incidence of two or more light beams emitted from said light source means from across in a vertical-scanning cross section to the deviation side of said deflection means, (2-1-4) The deviation side and said record-medium side of said deflection means have an optical conjugation relation with said image formation means in a vertical-scanning cross section, (2-1-5) The bus-bar configuration of two or more of said rotation unsymmetrical lenses is mirror symmetry to a symmetry axis, (2-1-6) The bus-bar of one [ at least ] lens side of two or more of said rotation unsymmetrical lenses is having shifted in the direction of vertical scanning to the optical axis of this lens (2-1-7), Said image formation means is characterized by having a cylindrical lens etc.

[0028]

[Embodiment of the Invention] The important section schematic diagram showing refractive-power arrangement [ in / in drawing 1 / the vertical-scanning cross section of the operation gestalt 1 of the scan optical equipment of this invention ], Drawing 2 The important section perspective view after the optical deflector of the operation gestalt 1 of the scan optical equipment of this invention, Respectively drawing 3 (A) and (B) The horizontal-scanning sectional view and vertical-scanning sectional view for the principal part after the optical deflector of the operation gestalt 1 of the scan optical equipment of this invention, Drawing 4 is an important section sectional view before an optical deflector including the revolving shaft of the optical deflector of the operation gestalt 1 of the scan optical equipment of this invention, and the optical axis C of an optical means (vertical-scanning sectional view). In addition, these scan optical equipment is used for laser beam printer equipment.

[0029] Each element of the scan optical equipment before the optical deflector first shown in drawing 4 is explained.

[0030] In drawing 4, 110a and 110b have a light source means 102 to have the laser light-emitting parts (laser chip) 102a and 102b which are the collimation laser light source sections respectively, for example, consist of semiconductor laser, and the collimator lenses 103a and 103b prepared corresponding to these laser light-emitting parts 102a and 102b. the light beam (laser beam) which each laser light-emitting parts 102a and 102b in this operation gestalt are formed on different substrate 121a and 121b, respectively, and emitted collimator lenses 103a and 103b from the laser light-emitting parts 102a and 102b — abbreviation — it considers as an parallel light beam and parallel incidence is carried out to the oblique incidence optical system 101 mentioned later to the optical axis C.

[0031] 101 is oblique incidence optical system, it consists of the cylindrical lens (cylinder lens) as an optical element which has forward refractive power, and this cylindrical lens 101 has forward refractive power only in a vertical-scanning cross section, and the parallel shift

(eccentricity) of the optical axis C of this cylindrical lens 101 is carried out to the optical axis D of the two collimation laser light source sections 110a and 110b (Da, Db). two or more light beams injected according to this oblique incidence optical system 101 with this operation gestalt from the two collimation laser light source sections 110a and 110b — deviation side 1a of an optical deflector 1 — receiving — the inside of a vertical-scanning cross section — the optical axis C of a cylindrical lens 101 — receiving — abbreviation — it is made to shoot slanting ON by whenever [ same incident angle ] (include angle symmetrical with abbreviation), and space separation is performing that glory way separation. In addition, collimator lenses 103a and 103b and a cylindrical lens 101 constitute an element of an optical means respectively.

[0032] 1 is an optical deflector as a deflection means, for example, consists of the polygon mirror, it is arranged so that deviation side (reflector) 1a of this optical deflector 1 may be located near the condensing location P of two or more laser beams condensed by the oblique incidence optical system 101, and it is rotating with constant speed in the direction of arrow-head A by the driving means (un-illustrating) of a motor etc.

[0033] Next, each element which constitutes the scan optical equipment shown in drawing 1 - drawing 3 is explained. The same code number is given to the same element as the element shown in drawing 4 R > 4 in drawing 1 - drawing 3.

[0034] The situation after two light beams (beam of light) which carried out oblique incidence to the optical axis C of the oblique incidence optical system 101 which is a direction perpendicular to deviation side 1a of the polygon mirror 1 in drawing 1 - drawing 3 at the include angle whose chief ray is 6 degrees symmetrical with abbreviation carry out deviation reflection by deviation side 1a is shown. Namely, two light beams make the include angle of 12 degrees, and it carries out outgoing radiation from the polygon mirror 1.

[0035] In drawing 1 - drawing 3, 2 (2a, 2b) is two oblique incidence beams of light (light beam) by which deviation reflection was carried out by the polygon mirror, the height of the direction of vertical scanning on deviation side (polygon mirror side) 1a of this polygon mirror 1 is in abbreviation etc. by carrying out, and deviation reflection of it is carried out in the deviation location.

[0036] 12 is an image formation means and it has two ftheta lenses (image formation optical system) 12a and 12b which have a f-theta property. Two ftheta lenses 12a and 12b are formed corresponding to light beam 2a emitted from two laser light-emitting parts 102a and 102b, and 2b, respectively. this — The location where it differs on the photoconductor drum side 10 as a scan layer-ed (record-medium side) is made to carry out image formation of the light beam based on the image information by which deviation reflection was carried out by the polygon mirror 1, respectively.

[0037] The ftheta lens 12 consists of ftheta lens 12b which consists of ftheta lens 12a which consists of toric lens 4b as the cylindrical lens 3 which has refractive power predetermined in a horizontal-scanning cross section, and a rotation unsymmetrical lens which consists of the lens configuration mentioned later, and toric lens 4a as this cylindrical lens 3 and a rotation unsymmetrical lens functionally. In addition, each toric lenses 4a and 4b paste up or arrange [ contiguity ], and constitute an element of the two-step toric lens 4. The cylindrical lens 3 is shared between ftheta lens 12a and ftheta lens 12b.

[0038] The two-step toric lens 4 in this operation gestalt has separated in the direction of vertical scanning at the toric lenses 4a and 4b of two upper and lower sides, as shown in drawing 3 (B), two above-mentioned oblique incidence beam-of-light 2a and 2bs are carrying out incidence to these toric lenses 4a and 4b independently, respectively, and it is arranged so that beam-of-light spacing may be set to 19.2mm in respect of outgoing radiation. This consists of these operation gestalten so that installation of the optical-path bending mirrors (separation mirror) 6 and 8 mentioned later may be attained without interfering in the direction of vertical scanning.

[0039] Moreover, the bus-bar configuration which the optical axis of each toric lenses 4a and 4b is the light beam and abbreviation parallel which carry out incidence to this lens, and connects the meridian top-most vertices of these toric lenses 4a and 4b consists of the curve which curved in the direction of vertical scanning respectively. Moreover, the bus-bar configuration of

each toric lenses 4a and 4b is mirror symmetry to a symmetry axis x.

[0040] A cylindrical lens 3 does not have refractive power in a vertical-scanning cross section, but only the two-step toric lens 4 is participating in the image formation in this cross section.

[0041] 6, 7, 8, and 9 are optical-path bending mirrors respectively, and they have led the corresponding light beam to the exposure location where it differs on the 10th page of the photoconductor drum as a record medium, respectively. 11 (11a, 11b) is the scanning line on a photoconductor drum side.

[0042] the collimator lenses 103a and 103b with which light beam (laser beam) 2a emitted from two laser light-emitting parts 102a and 102b in this operation gestalt and 2b correspond with these laser light-emitting parts 102a and 102b — abbreviation — it becomes an parallel light beam and incidence is carried out to the cylindrical lens 101. It injects in the state of an parallel light beam as it is in a horizontal-scanning cross section among the parallel light beams which carried out incidence to the cylindrical lens 101. Moreover, it converges into a vertical-scanning cross section, and image formation is mostly carried out as a line image near the deviation side (reflector) 1a of the polygon mirror 1. This is the usual means used in order to amend \*\*\*\* of the direction of vertical scanning of deviation side 1a of the polygon mirror 1, and makes conjugate optically deviation side 1a of the polygon mirror 1, and the photoconductor drum side 10 with the ftheta lens 12 into the vertical-scanning cross section. That is, it falls in a vertical-scanning cross section, and amendment optical system is constituted. moreover, two light beam 2a at this time and 2b — deviation side 1a — receiving — abbreviation — oblique incidence is carried out by whenever [ same incident angle ].

[0043] And two or more light beams 2 (2a, 2b) by which deviation reflection was carried out are led to the exposure location on the photoconductor drum side 10 through the optical-path bending mirror (6-7, 8-9) which corresponds with the ftheta lens 12, respectively by the polygon mirror 1. The scanning line 11 (11a, 11b) is drawn by shaft orientations (main scanning direction) by rotation of this polygon mirror 1, and this scanning line 11 (11a, 11b) is formed in the direction of vertical scanning perpendicular to a main scanning direction at equal intervals of rotation of the photoconductor drum which synchronized with rotation of this polygon mirror 1. Thus, by irradiating independently the two scanning lines 11a and 11b on one photoconductor drum side 10 at coincidence, the development of two colors is attained by one rotation of a photoconductor drum, and, thereby, improvement in the speed of color printing can be realized.

[0044] On the drawing of the two-step toric lens 4, if its attention is paid to the lens configuration of lower toric lens 4a to a symmetry axis x, both the bus-bars of the 1st lens side R1 by the side of the polygon mirror 1 of this toric lens 4a and the 2nd lens side R2 by the side of a photoconductor drum are in abbreviation etc. by making it the locus of the oblique incidence beam of light which carries out incidence as shown in drawing 5 (A) and (B), and have bus-bar deflection here. That is, the bus-bar configuration which connects the meridian top-most vertices of toric lens 4a with this operation gestalt forms from the curve which curved in the direction of vertical scanning. In addition, with the direction of vertical scanning of toric lens 4a, it is the thing of a direction perpendicular to the optical axis and main scanning direction of this lens.

[0045] With this bus-bar deflection, with this operation gestalt, the rotation of a light beam which carries out incidence to a main scanning direction with a field angle was lost, and this has obtained the good image formation engine performance. Drawing 6 is the explanatory view having shown this principle.

[0046] Each beams of light U and L of the circumference of the chief ray P which the field angle attached to the main scanning direction receive the refractive power by which a light beam goes in the direction of chief ray P in a y-z side by incurvating the bus-bar of toric lens 4a in the direction of vertical scanning along with the scanning line, as shown in this drawing. Consequently, it does not rotate to the circumference of a chief ray P, but image formation of each beams of light U and L is carried out good.

[0047] In this operation gestalt, the amount of scanning-line curves of the 1st lens side R1 in the maximum scan field angle is about 1.09mm, the 2nd lens side R2 is about 1.87mm, and it is the bus-bar with which the amount of bus-bar curves met mostly 1.16mm, 1.62mm, and a

scanning-line curve to it, respectively.

[0048] Furthermore, the specified quantity shift of the bus-bar of the both sides of the 1st lens side R1 of toric lens 4a and the 2nd lens side R2 is made to turn in the direction of vertical scanning down on a drawing ( drawing 3 (B) ) to the optical axis of this toric lens 4a respectively with this operation gestalt. The absolute value of the left-vertical shaft of drawing 5 (A) and (B) shows the shift amount from the optical axis of a bus-bar. The 1st lens side R1 is about 52.4mm, and the 2nd lens side R2 is about 2.1mm. The shift effectiveness of this bus-bar has amended the scanning-line curve on a photoconductor drum side with an oblique incidence beam of light good with this operation gestalt.

[0049] The expression of the bus-bar configuration of the lens side is indicated to be the important section schematic diagram of the lens side with the bus-bar which curved to drawing 7 of a toric lens. In this drawing, let the direction of an optical axis of a lens into a x axis, and let a main scanning direction be the y-axis. A bus-bar is a curve which connected meridian top-most vertices, and the z-axis component of a bus-bar is  $Z = \sum A_i Y_i$  ( $i = 0, 1$  and  $2, \dots$ ) as a polynomial of a y-coordinate.

It is come out and expressed. With this operation gestalt, it used as a polynomial to the 8th order. This polynomial expresses the amount of curves of the direction of vertical scanning which projected the bus-bar on the y-z side, and supports drawing 5 (A) mentioned above and (B).

[0050] The scanning-line curve on the photoconductor drum side of this operation gestalt is shown in drawing 8 . As shown in this drawing, in the range of \*\*150mm of effective scan fields, 10-micrometer less or equal is stopped, and also to the scanning density of 600dpi (resolution of 42.3 micrometers), scanning-line deflection is 1/4 pixel or less, and has secured sufficient optical-character ability.

[0051] Moreover, there is an ftheta property as optical-character ability important as this kind of scan optical equipment. ftheta property with ftheta lens of the two-sheet system of this operation gestalt is shown in drawing 9 . ftheta property is settled in the error of 0.25% or less of abbreviation in the range of \*\*150mm of effective scan fields, as shown in this drawing, and even if it uses the toric lens of this operation gestalt with the curved bus-bar, it has secured sufficient optical-character ability.

[0052] Drawing 10 is the explanatory view having shown three spot configurations in 50%, 13.5%, and 5% to peak intensity at the spot on the photoconductor drum side of this operation gestalt. It turns out that the good image formation engine performance is obtained over a scan field at large in the main scanning direction in the image quantity location of \*\*one hundred percent, \*\*70 percent, and 0 percent (on a horizontal-scanning shaft), as shown in this drawing. The diameter of a spot forms strong minute spot with the diameter of a spot of a main scanning direction as sufficient [ the diameter of a spot of 58 micrometers and the direction of vertical scanning ] as 64 micrometers 13.5% by defocusing (def) =0mm on a shaft.

[0053] With this operation gestalt, the amount of bus-bar curves of the two-step toric lens 4 should just give the configuration of mirror symmetry to a symmetry axis in the toric lenses 4a and 4b of two upper and lower sides by having set the oblique incidence include angle of two or more light beams (oblique incidence beam of light) which carry out oblique incidence to deviation side 1a of the polygon mirror 1 as the include angle symmetrical with abbreviation to the deviation side of this polygon mirror 1. namely, the toric lens of two upper and lower sides — if a lens design is performed to one of lenses inside — the lens of another side — as a mirror symmetry configuration — naturally — it can be found — the process of thereby a design — it can simplify — and the function of a toric lens — mutual — etc. — it spreads — it can carry out.

[0054] Moreover, what is necessary is to design only the toric lens corresponding to an oblique incidence beam of light like the above-mentioned, since one light beam is made into an oblique incidence beam of light to a deviation side between two light beams (incident ray) and a vertical-incidence beam of light, then the latter can use the usual toric lens for the light beam of another side in a vertical-scanning cross section in this operation gestalt. furthermore, the fabrication [ incurvate / a bus-bar ] using plastic material — not depending — it does not obtain but is

inferior to dependability compared with a glass ingredient. Therefore, dependability is also securable if the toric lens corresponding to one [ at least ] light beam is constituted from a usual glass ingredient.

[0055] In addition, although the multi-beam scan was performed using two or more light beams in this operation gestalt, incidence of the single light beam is carried out from across into a vertical-scanning cross section to the deviation side of an optical deflector, for example, and even if it forms the lens configuration of the rotation unsymmetrical lens (toric lens) which constitutes ftheta lens as an image formation means like the above-mentioned, it is applicable [ this invention ] like the above-mentioned operation gestalt 1.

[0056] Drawing 11 (A) and (B) are the important section sectional views for the principal part after the optical deflector of the operation gestalt 2 of the scan optical equipment of this invention respectively, this drawing (A) is a horizontal-scanning sectional view, and this drawing (B) is a vertical-scanning sectional view. The same code number is given to the same element as the element shown in drawing 3 R> 3 in this drawing (A) and (B).

[0057] the optical axis of the toric lenses 24a and 24b of two upper and lower sides which constitute this two-step toric lens 24 using the two-step toric lens 24 to which the usual bus-bar configuration which showed a different point from the above-mentioned operation gestalt 1 in this operation gestalt by said drawing 15 is not curving — an oblique incidence beam of light (incident beam) — receiving — the inside of a vertical scanning cross section — specified quantity alpha \*\*\*\*\* — they are things. Other configurations and optical operations are the same as that of the above-mentioned operation gestalt 1 and abbreviation, and, thereby, have acquired the same effectiveness.

[0058] That is, also when only the specified quantity alpha leans the optical axis (a broken line illustrates) of the toric lenses 24a and 24b of two upper and lower sides which constitute this two-step toric lens 24 in a vertical-scanning cross section to an oblique incidence beam of light (incident beam) using the usual two-step toric lens 24 same with having been shown in said drawing 15, degradation of the image formation engine performance is remarkably improvable in this drawing (B). It is because the bus-bar of the 2nd lens side R2 of toric lens 24a (24b) will curve in the direction of vertical scanning as it leaned only the include angle alpha if this is seen from an oblique incidence beam of light. Therefore, the effectiveness equivalent to having incurvated the bus-bar of the 2nd lens side R2 of each toric lenses 24a and 24b in the direction of vertical scanning can be demonstrated. For example, the image formation engine performance can be made to improve remarkably by leaning in the include angle of about alpha= 6.5 degrees, and the direction of vertical scanning at the time of theta= 3 degrees of oblique incidence angles.

[0059] In addition, since it depends for the so-called amount of bus-bar curves using this approach on the bus-bar configuration within a field including a lens optical axis, and lens \*\*\*\*\* alpha, there is no degree of freedom of a design about one operation gestalt mentioned above. However, considerable effectiveness can be demonstrated by the toric lens which consists of the conventional glass ingredient in simple.

[0060] The important section perspective view after the optical deflector of the operation gestalt 3 of the scan optical equipment of this invention, drawing 13 (A), and (B) of drawing 12 are the horizontal-scanning sectional views and vertical-scanning sectional views for the principal part after the optical deflector of the operation gestalt 3 of this invention respectively. The same code number is given to the same element as the element shown in drawing 2 and drawing 3 in drawing 12 and drawing 13.

[0061] A different point from the above-mentioned operation gestalt 1 in this operation gestalt is having constituted ftheta lens as an image formation means from one lens (one-sheet system ftheta lens). Other configurations and optical operations are the same as that of the above-mentioned operation gestalt 1 and abbreviation, and, thereby, have acquired the same effectiveness.

[0062] that is, in this drawing, 52 is ftheta lens of an one-sheet system, and this ftheta lens 52 is shown in drawing 13 (B) — as — the inside of a vertical-scanning cross section — the lenses (rotation unsymmetrical lens) 52a and 52b of two upper and lower sides — separating — \*\*\*\* —

- this — two lenses 52a and 52b are arranged corresponding to oblique incidence beam (oblique incidence beam of light) 2a and 2b, respectively.

[0063] The bus-bar of two lenses 52a and 52b which constitute the one-sheet system ftheta lens 52 in this operation gestalt has given the bus-bar deflection to the direction of vertical scanning which met the scanning-line locus of an incident beam like the two-step toric lens of ftheta lens of the two-sheet system of the operation gestalt 1 mentioned above. The image formation engine performance is made to improve according to the principle of control of the beam rotation of drawing 6 R> 6 which this mentioned above.

[0064] In addition, although it becomes disadvantageous to lengthen the lens back compared with ftheta lens of a two-sheet system in the case of ftheta lens of the one-sheet system in this operation gestalt and the degree of freedom of mirror arrangement is lost, components mark can be reduced and there is a merit of being able to attain low cost-ization.

[0065] Next, optical arrangement of the scan optical equipment of this invention shown in said drawing 2 is explained using drawing 14. XYZ system of coordinates as shown in drawing 14 were considered, the center of rotation of the polygon mirror 1 was made into the zero (0, 0, 0), and the coordinate of the zero (- in drawing shows) of each field was expressed.

[0066] In addition, the case where deviation reflection of the light beam is carried out by the polygon mirror 1 in the direction parallel to a X-Z flat surface here is considered, and since it is symmetrical about a X-Y flat surface about two toric lenses 4a and 4b, the coordinate of only toric lens 4a of one side is shown in the following table -1. The polygon mirror 1 is forward 8 face piece, and uses the deflection angle phi65 degree thing.

[0067] (Coordinate of the zero of each side)

[0068]

[Table 1]

( 表 - 1 )

	X 軸座標 単位 (mm)	Y 軸座標 単位 (mm)	Z 軸座標 単位 (mm)
ポリゴンミラー1の回転中心	0	0	0
偏向面 1a	33.07	-16.49	0
シリンドリカルレンズ3の入射面	63.35	-15.88	0
シリンドリカルレンズ3の出射面	86.97	-15.88	0
トーリックレンズ4aの入射面	139.67	-15.88	-10.24
トーリックレンズ4aの出射面	148.99	-15.88	-11.22
感光ドラム面10 (像面)	450.33	-15.88	-42.89

Next, the direction cosine of the field normal of each of said side is shown in the following table -2 and Table -3.

[0069]

[Table 2]

( 表 - 2 )

	各面の方向余弦 (X成分)		
	gx (x)	gx (y)	gx (z)
偏向面 1a	0.89493	-0.44620	0
シリンドリカルレンズ3の入射面	1.00000	0	0
シリンドリカルレンズ3の出射面	1.00000	0	0
トーリックレンズ4aの入射面	0.99452	0	-0.10453
トーリックレンズ4aの出射面	0.99452	0	-0.10453
感光ドラム面10 (像面)	0.99452	0	-0.10453

[0070]

[Table 3]

	各面の方向余弦 (y成分)		
	gy (x)	gy (y)	gx (z)
偏向面 1 a	0	1.00000	0
シリンダリカルレンズ 3 の入射面	0	1.00000	0
シリンダリカルレンズ 3 の出射面	0	1.00000	0
トーリックレンズ 4 a の入射面	0	1.00000	0
トーリックレンズ 4 a の出射面	0	1.00000	0
感光ドラム面 10 (像面)	0	1.00000	0

Next, the numerical example of a cylindrical lens 3 is shown in the following table -4.

[0071]

[Table 4]

( 表 - 4 )

入射面の X - Y 平面内での曲率半径	-65.84
出射面の X - Y 平面内での曲率半径	-72.13
入射面の X - Z 平面内での曲率半径	0
出射面の X - Z 平面内での曲率半径	0
波長 $\lambda = 675\text{nm}$ における屈折率	1.619
軸上肉厚	23.62

Next, the numerical example of toric lens 4a is shown in the following table -5.

[0072]

[Table 5]

( 表 - 5 )

波長 $\lambda = 675\text{nm}$ における屈折率	1.527
軸上肉厚	9.38

Moreover, the configuration of the lens side of toric lens 4a is determined by the system of coordinates shown in drawing 7, and shows the numerical example below.

[0073]

Plane of incidence of toric lens 4a ( $Y \geq 0$ ) ( $Y < 0$ )

RU 0.00000x100 RI 0.00000x100 KyU 0.00000x100 Kyl 0.00000x100 B4U 0.00000x100 B4I 0.00000x100 B6U 0.00000x100 B6I 0.00000 x100 B8U 0.00000x100 B8I 0.00000x100 B10U 0.00000 x100B10I 0.00000 x100 (Z)

A0 - 5.24371x10<sup>1</sup> A1 - 8.22716x10<sup>-5</sup> A2 - 4.35411x10<sup>-4</sup> A3 2.41485x10<sup>-7</sup> A4 9.27963x10<sup>-9</sup> A5 - 3.83684x10<sup>-11</sup> A6 1.36309x10<sup>-12</sup> A7 1.07112x10<sup>-17</sup> A8 3.49275x10<sup>-23</sup> Outgoing radiation side of toric lens 4a ( $Y \geq 0$ ) ( $Y < 0$ )

RU - 1.79366x10<sup>2</sup> RI - 1.79366x10<sup>2</sup> KyU 3.29536x10<sup>-1</sup> Kyl 1.45075x10<sup>-1</sup> B4U - 1.03513x10<sup>-8</sup> B4I - 1.07810x10<sup>-8</sup> B6U - 4.64076x10<sup>-13</sup> B6I 1.19697x10<sup>-12</sup> B8U 1.42729x10<sup>-16</sup> B8I - 8.93782 x10<sup>-17</sup> B10U 1.57191x10<sup>-20</sup> B10I 1.22695x10<sup>-20</sup> (Z)

[ [ A0 3.70351x10<sup>-13</sup> A7 -2.61817x10<sup>-15</sup> A8 1.03539x10<sup>-16</sup> ] 0074] -2.10019x100 A1 - 4.86900x10<sup>-4</sup> A2 -5.22798x10<sup>-4</sup> A3 -2.95750x10<sup>-7</sup> A4 -9.24222x10<sup>-9</sup> A5 8.75580x10<sup>-13</sup> A6

[Effect of the Invention]

(A1) By giving the bus-bar deflection which met the scanning-line locus of an incident beam in the lens configuration of the toric lens which is a rotation unsymmetrical lens which constitutes an image formation means (ftheta lens) like the above-mentioned according to this invention Degradation of the problem of the oblique incidence scan optical system which was not able to be solved conventionally, i.e., the image formation engine performance, is solved, being possible in space separation of two or more beams according [ on the scan optical equipment of a compact expansion system, and ] to oblique incidence — carrying out — moreover, the deviating point on the deviation side of the optical deflector of two or more light beams — the direction of

vertical scanning — abbreviation — by making the same location condense Thin-shape-izing and lightweight-izing of this optical deflector can be attained, and lightweight-ization can attain the scan optical equipment in which high-speed rotation is more possible.

[0075] (A2) Like the above-mentioned, by carrying out incidence of the oblique incidence beam at an include angle symmetrical with abbreviation to a deviation side, the bus-bar curve configuration of the toric lens as a rotation unsymmetrical lens serves as mirror symmetry to a symmetry axis, and, according to this invention, the scan optical equipment which can attain simplification of a design by this can be attained again.

[0076] (A3) According to this invention, by making the specified quantity shift of the bus-bar of one [ at least. ] lens side of a toric lens carry out in the direction of vertical scanning to an optical axis, the scan optical equipment which can amend a scanning-line curve good can be further attained like the above-mentioned.

[0077] (B1) according to this invention — the optical axis of the usual toric lens [ like / the above-mentioned ] — an oblique incidence beam of light — receiving — the inside of a vertical-scanning side — setting — specified quantity \*\*\*\*\* — by things Degradation of the problem of the oblique incidence scan optical system which was not able to be solved conventionally, i.e., the image formation engine performance, is solved. being possible in space separation of two or more beams according [ on the scan optical equipment of a compact expansion system, and ] to oblique incidence — carrying out — moreover, the deviating point on the deviation side of the optical deflector of two or more light beams — the direction of vertical scanning — abbreviation — by making the same location condense Thin-shape-izing and lightweight-izing of this optical deflector can be attained, and lightweight-ization can attain the scan optical equipment in which high-speed rotation is more possible.

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[Translation done.]

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**DESCRIPTION OF DRAWINGS**

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**[Brief Description of the Drawings]**

**[Drawing 1]** The important section schematic diagram showing the refractive-power arrangement in the vertical-scanning cross section of the operation gestalt 1 of this invention

**[Drawing 2]** The important section perspective view for the principal part of the operation gestalt 1 of this invention

**[Drawing 3]** The important section sectional view for the principal part of the operation gestalt 1 of this invention

**[Drawing 4]** The important section sectional view before the optical deflector of the operation gestalt 1 of this invention

**[Drawing 5]** The explanatory view showing the bus-bar curve of the operation gestalt 1 of this invention

**[Drawing 6]** The principle Fig. having shown the principle which solves degradation of the image formation engine performance

**[Drawing 7]** The explanatory view showing the definition of a toric side with the curved bus-bar

**[Drawing 8]** The explanatory view showing the amount of scanning-line curves obtained with the operation gestalt 1 of this invention

**[Drawing 9]** The explanatory view showing ftheta property acquired with the operation gestalt 1 of this invention

**[Drawing 10]** The spot image obtained with the operation gestalt 1 of this invention

**[Drawing 11]** The important section sectional view for the principal part of the operation gestalt 2 of this invention

**[Drawing 12]** The important section perspective view for the principal part of the operation gestalt 3 of this invention

**[Drawing 13]** The important section sectional view for the principal part of the operation gestalt 3 of this invention

**[Drawing 14]** The explanatory view explaining optical arrangement of the scan optical equipment shown in drawing 2

**[Drawing 15]** The important section schematic diagram of the optical system of conventional scan optical equipment

**[Drawing 16]** The explanatory view explaining the trouble of oblique incidence

**[Drawing 17]** The explanatory view explaining the trouble of oblique incidence

**[Drawing 18]** The explanatory view explaining the trouble of oblique incidence

**[Description of Notations]**

1 Deflection Means (Polygon Mirror)

2 (2a, 2b) Oblique incidence beam of light

3 23 Cylindrical lens

4 24 Two-step toric lens

4a, 4b Rotation unsymmetrical lens (toric lens)

24a, 24b Toric lens

6, 7, 8, 9 Optical-path bending mirror

10 Scan Layer-ed (Photoconductor Drum Side)

11 (11a, 11b) Scanning line  
12, 42, 52 Image formation means (ftheta lens)  
12a, 12b ftheta lens  
101 Oblique Incidence Optical System (Cylindrical Lens)  
102 Light Source Means  
102a, 102b Laser light-emitting part  
103a, 103b Collimator lens  
110a, 110b Collimation laser light source section

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[Translation done.]

\* NOTICES \*

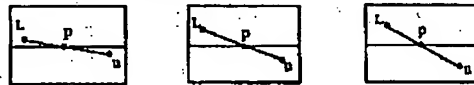
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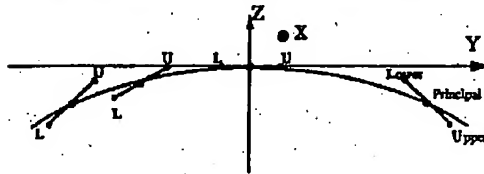
## DRAWINGS

### [Drawing 17]

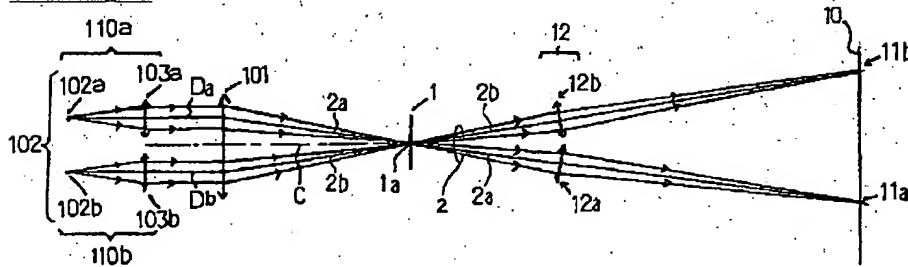
(A) ポリゴン反射面上のメリ断面光線の傾き



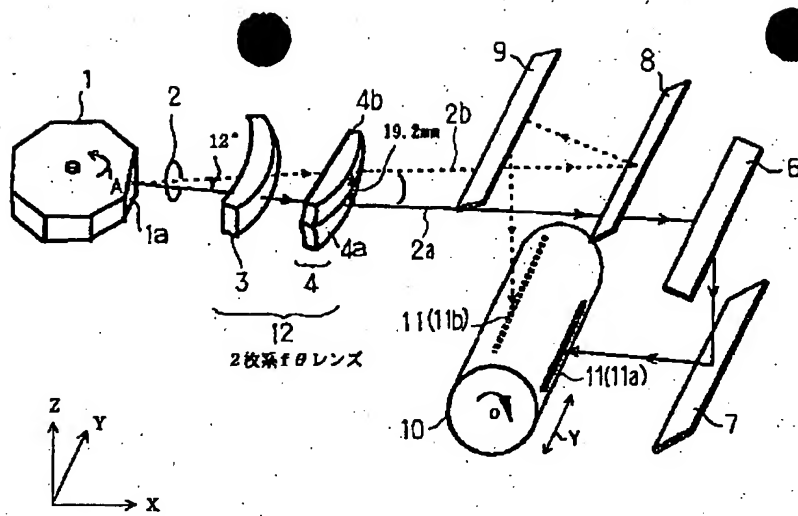
(B) 偏向走査後の主光線軌跡とメリ Upper/Lower 光線の関係



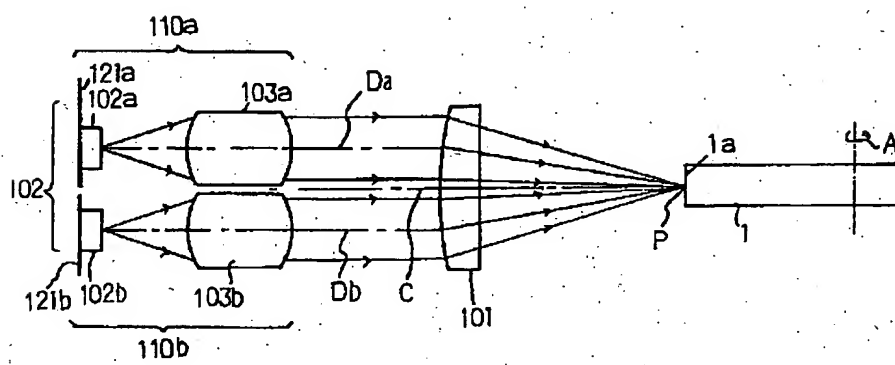
### [Drawing 1]



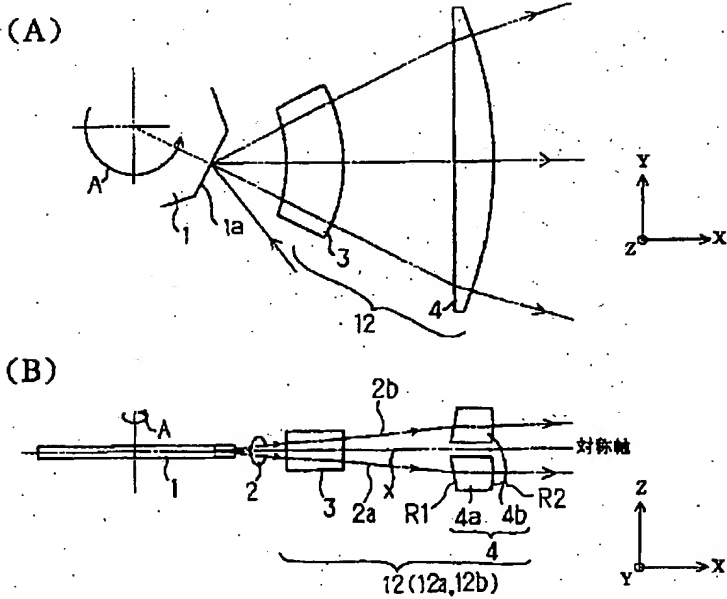
### [Drawing 2]



[Drawing 4]



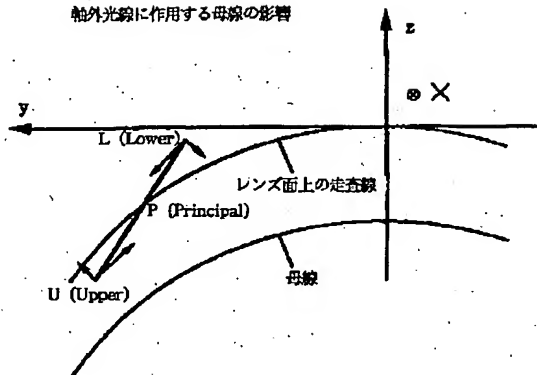
[Drawing 3]



[Drawing 6]

## 回転対策

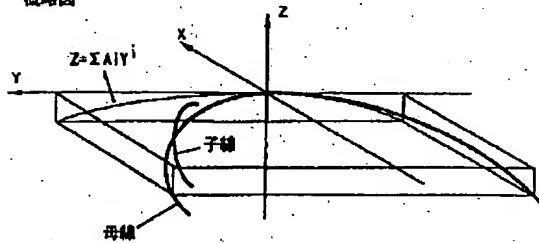
軸外光線に作用する母線の影響



## [Drawing 7]

湾曲した母線をもつ特殊トーリック面

概略図



表現式

(母線)

$$Z = \frac{Y^2/R_u}{1 + \sqrt{1 - (1 + K_{yu}) (Y/R_u)^2}} + B_{4u} Y^4 + B_{6u} Y^6 + B_{8u} Y^8 + B_{10u} Y^{10} \quad (Y \geq 0)$$

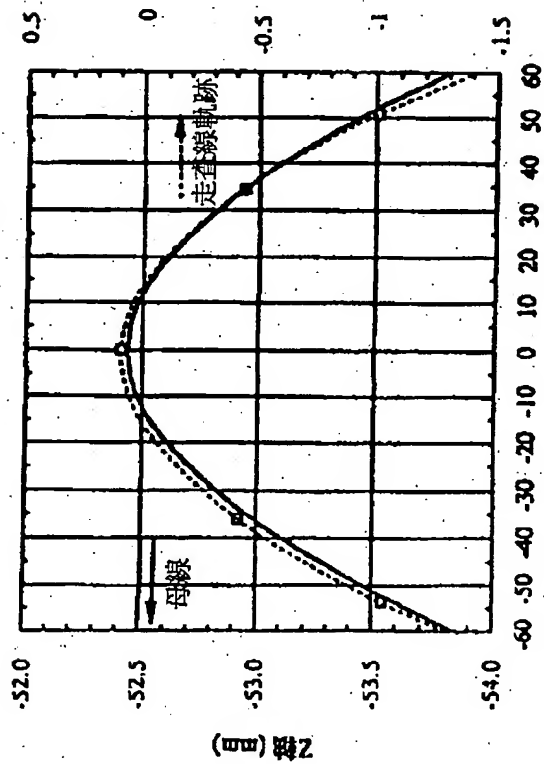
$$Z = \frac{Y^2/R_l}{1 + \sqrt{1 - (1 + K_{yl}) (Y/R_l)^2}} + B_{4l} Y^4 + B_{6l} Y^6 + B_{8l} Y^8 + B_{10l} Y^{10} \quad (Y < 0)$$

$$Z = \sum_{i=0}^n A_i Y^i \quad (i \leq 8)$$

## [Drawing 5]

(A)

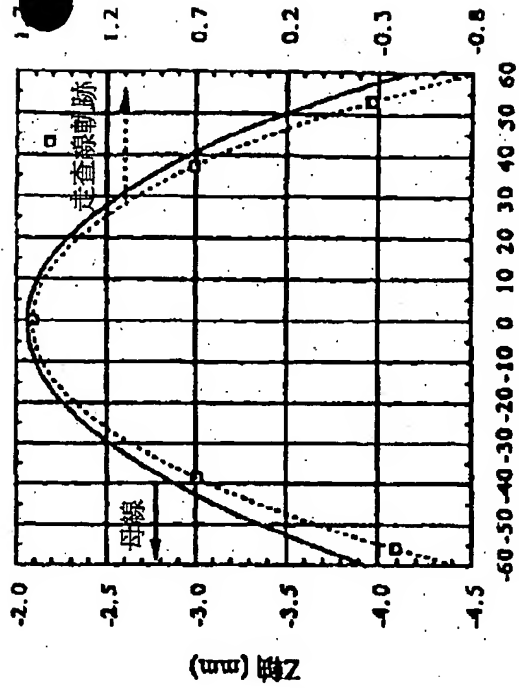
R 1 面 母線の Y-Z 断面形状



主走査 y 軸 (mm)

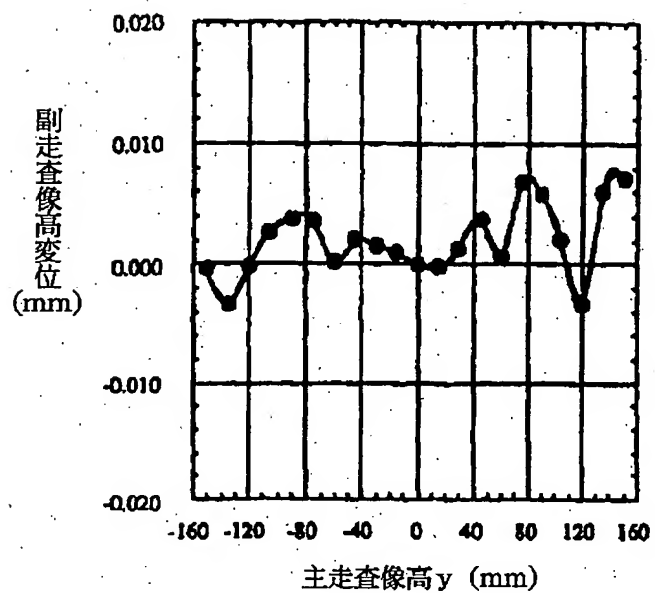
(B)

R 2 面 母線の Y-Z 断面形状



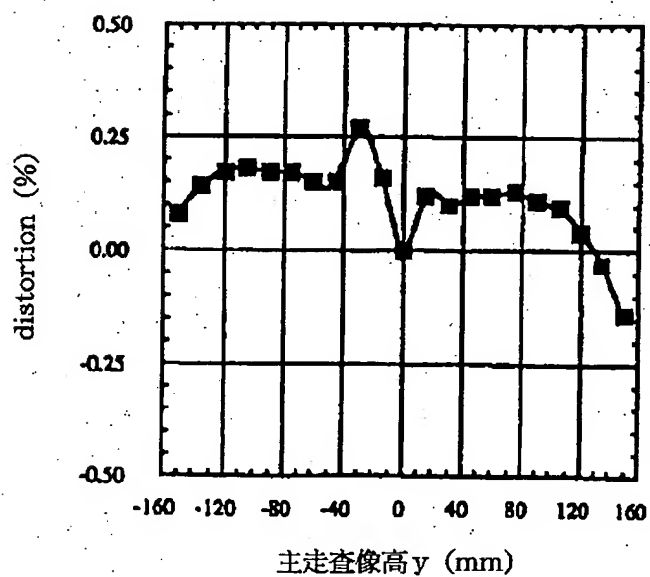
主走査 y 軸 (mm)

# 走査線湾曲



[Drawing 9]

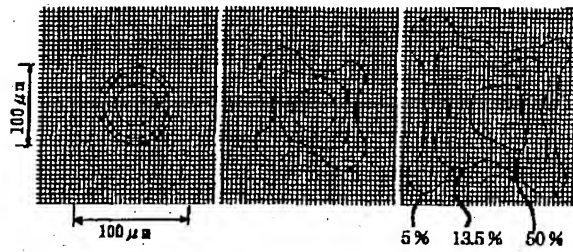
## $f \theta$ 特性



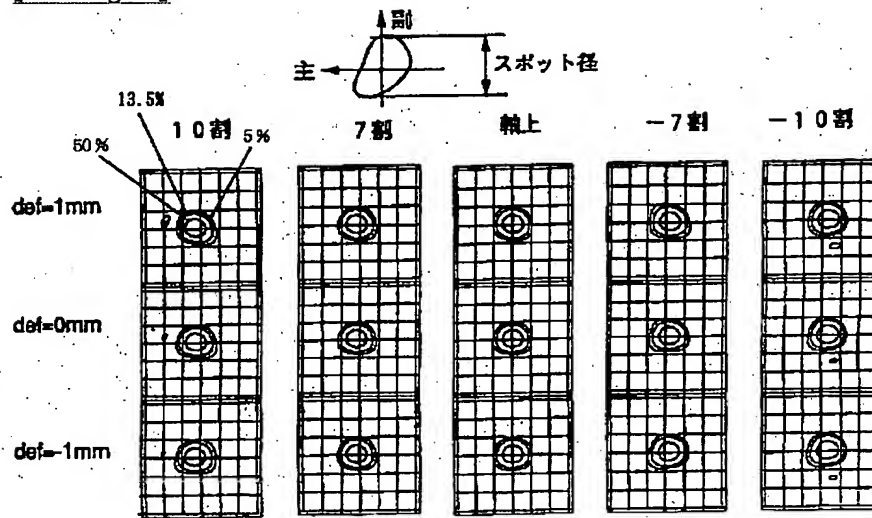
[Drawing 18]



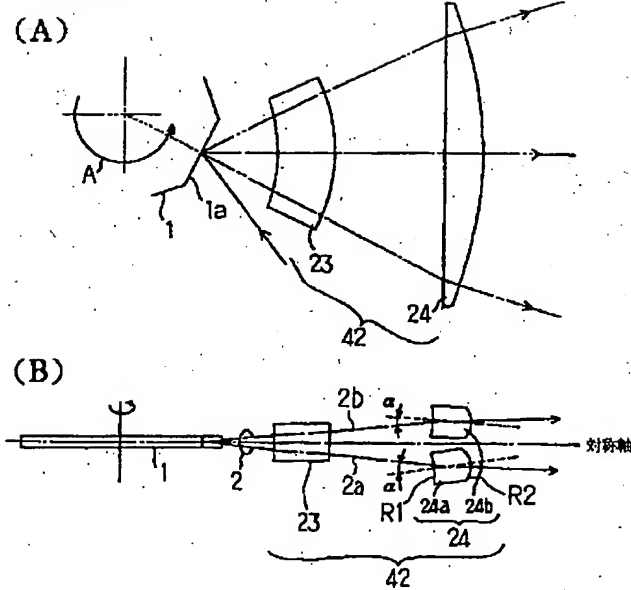
(軸上) → 主走査画角大



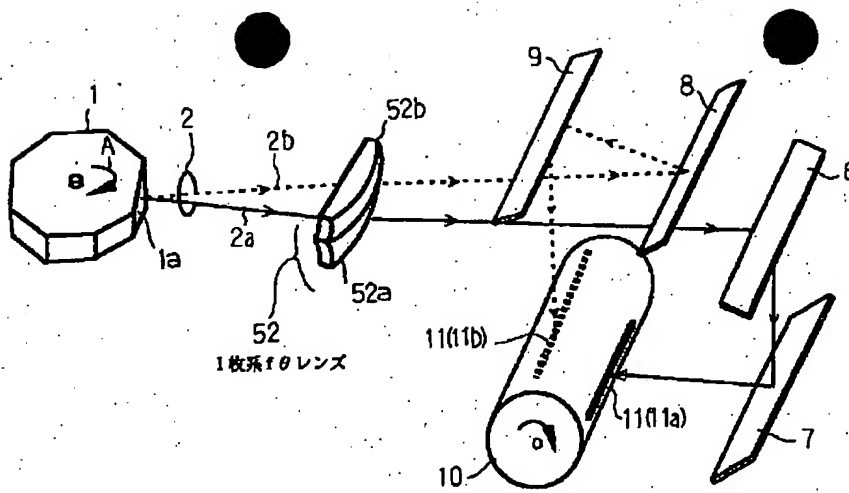
[Drawing 10]



[Drawing 11]

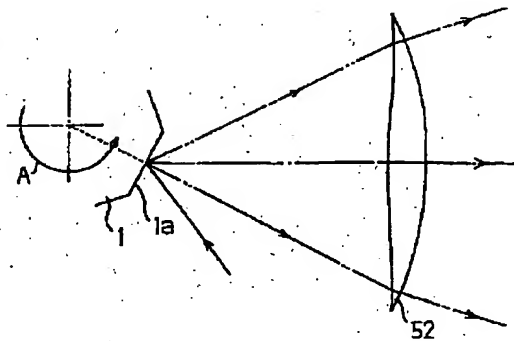


[Drawing 12]

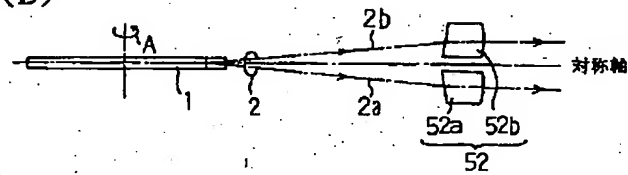


[Drawing 13]

(A)

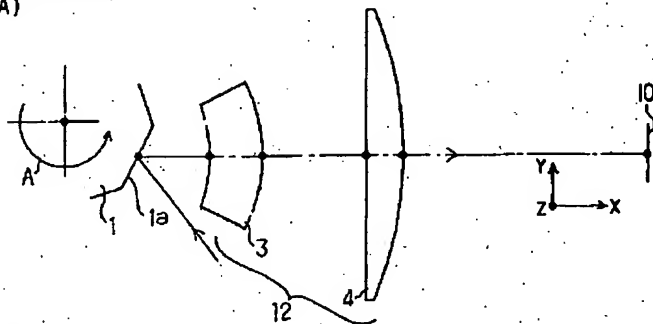


(B)

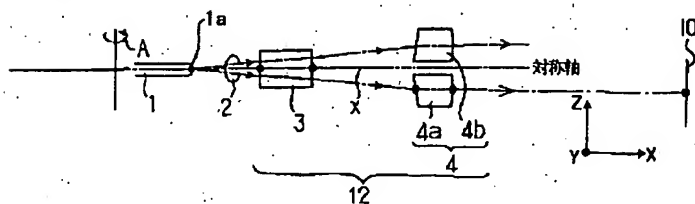


[Drawing 14]

(A)

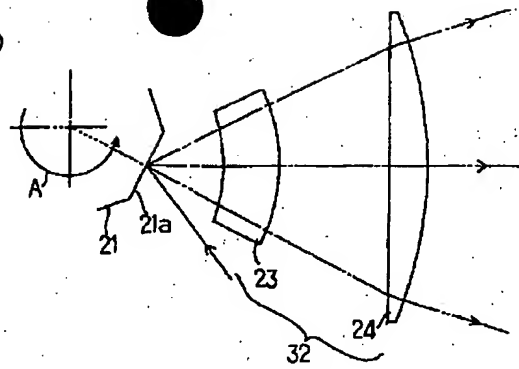


(B)

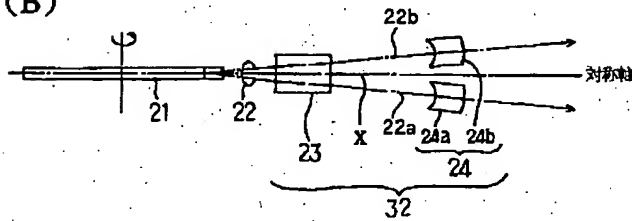


[Drawing 15]

(A)

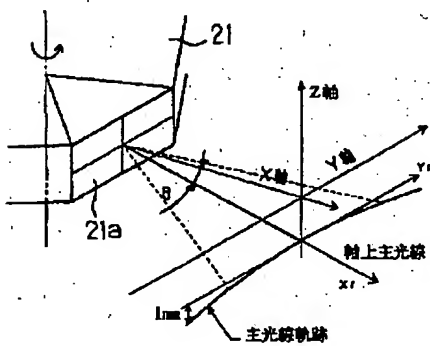


(B)

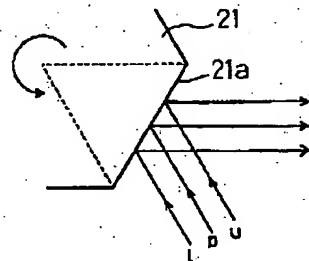


[Drawing 16]

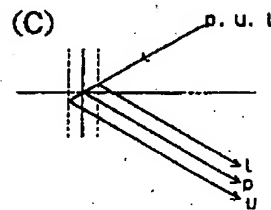
(A) 走査線湾曲



(B) ビームの回転



(C)



(D)



[Translation done.]